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Tensors

K.F. Riley, M P Hobson and S J Bence, Mathematical methods for physics and Engineering, The Third Version, Cambridge Univ. Press, 2006

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It may seem obvious that the quantitative description of physical processes cannot depend on the coordinate system in which they are represented. However, we may turn this argument around: since physical results must indeed be independent of the choice of coordinate system, what does this imply about the nature of the quantities involved in the description of physical processes? The study of these implications and of the classification of physical quantities by means of them forms the content of the present chapter.

Although the concepts presented here may be applied, with little modification, to more abstract spaces (most notably the four-dimensional space–time of special or general relativity), we shall restrict our attention to our familiar three-dimensional Euclidean space. This removes the need to discuss the properties of differentiable manifolds and their tangent and dual spaces. The reader who is interested in these more technical aspects of tensor calculus in general spaces, and in particular their application to general relativity, should consult one of the many excellent textbooks on the subject.§

Before the presentation of the main development of the subject, we begin by introducing the summation convention, which will prove very useful in writing tensor equations in a more compact form. We then review the effects of a change of basis in a vector space; such spaces were discussed in chapter 8. This is followed by an investigation of the rotation of Cartesian coordinate systems, and finally we broaden our discussion to include more general coordinate systems and transformations.

§ For example, R. D'Inverno, *Introducing Einstein's Relativity* (Oxford: Oxford University Press, 1992); J. Foster and J. D. Nightingale, *A Short Course in General Relativity* (New York: Springer, 2006); B. F. Schutz, *A First Course in General Relativity* (Cambridge; Cambridge University Press 1985).